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Column Tray

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5 The present invention relates to a column tray  
according to the precharacterizing clause of Claim 1  
and a column having such column trays.

10 In the case of columns having a high gas throughput,  
large flow cross-sections must be provided for the gas  
flow.

15 For this purpose, US 4,028,442 discloses that a column  
tray which is not flat should be provided for a column  
having a high gas throughput. In order to increase the  
flow cross-section for the gas throughput, the column  
tray has a grid which is undulating or formed with  
20 inclined or perpendicular sections and is supported on  
a support structure in the column. Owing to the  
inclined or perpendicular shape of the grid with the  
orifices formed therein for the gas flow, the flow  
cross-section is greater than in the case of a flat  
25 embodiment of the grid.

US 5,281,369 discloses column trays having a grid which is undulating or is arranged on a support structure. The grid is formed in such a way that the gas stream passes through the region of the wave summits while the liquid is collected in the valleys and emerges downwards through small holes. Since the gas stream and the liquid stream are passed along substantially separate routes through the column tray, a higher gas flow rate can be achieved with the same liquid throughput.

These known column trays have the disadvantage that they cannot be produced without considerable costs for corrosion-resistant materials. In addition, a support structure for the grids is required in the case of the known column trays.

It is therefore the object of the invention to provide a column tray which can be produced easily and economically from corrosion-resistant material and with which a high gas flow rate is achievable.

The object is achieved by a column tray according to the features of Claim 1. Advantageous embodiments of the invention are described in the dependent claims.

According to the features of Claim 1, the column tray comprises a tray and gas penetration holes which are formed in such a way that their orifices are perpendicular or inclined to the column tray, the tray having holes in which superstructures which have the gas penetration holes are arranged. Since the gas penetration holes are formed in the superstructures, it

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is possible to make the tray of the column tray flat. This has the advantage that the tray can be coated with highly corrosion-resistant materials, such as, for example, enamel and the plastics mentioned in the further claims. According to the invention, it may be possible also to form further gas penetration holes in the tray itself. According to the invention, however, gas penetration holes must also be formed in the superstructures in order to create a sufficiently large gas penetration cross-section.

The invention has the further advantage that the tray of the column tray can be formed from steel with a corrosion-resistant coating and the superstructures of more complicated design can be formed from a corrosion-resistant plastic and/or from glass. It is therefore possible - but not necessary - to form the column tray without the known support construction.

According to an embodiment of the invention, the superstructures have side walls which are substantially perpendicular to the column tray, and the gas penetration holes are formed in the side walls.

According to an embodiment of the invention, the gas penetration holes are in the form of longitudinal slots and preferably run in each case from a point above the liquid level, which is to form during operation on the column tray, up to the upper end region of the superstructures.

According to the invention, the side walls may have superstructures having a round, circular, polygonal,

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rectangular or square cross-section which corresponds to the cross-section of the holes of the tray in which the superstructures are arranged.

5 According to an embodiment of the invention, the superstructures have a hood to prevent the entry of the liquid into the superstructure and hence a disturbance of the gas flow in the opposite direction.

10 If required, the hood may have slots for providing additional gas penetration holes.

In order to provide a highly corrosion-resistant column tray, the tray is formed from enamelled steel, steel  
15 having a coating of a corrosion-resistant plastic, such as polytetrafluoroethylene (PTFE), perfluoroalkoxy polymers (PFA), polyvinylidene fluoride (PVDF), polyethylene (PE) or similar materials, from a corrosion-resistant special alloy or tantalum or at  
20 least substantially from plastic.

The superstructures should also be corrosion-resistant. For this purpose, the superstructures are formed from plastic, such as, for example, polytetrafluoroethylene  
25 (PTFE), perfluoroalkoxy polymers (PFA), polyvinylidene fluoride (PVDF) or polyethylene (PE) or from glass.

If the column tray is to be used as a liquid distributor or liquid redistributor, the tray has  
30 further holes in which distributor cups are arranged, the further holes preferably having a smaller cross-section than the holes for the superstructures.

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If required, small distributor tubes may be fastened in the bores of the distributor cups, preferably by screwing together or by a plug connection, in such a way that a targeted liquid distribution over the structured packings or random packings of the column can be ensured.

According to further embodiments, the superstructure in at least one hole can be arranged lower so that this superstructure can be used as an outflow pipe to the next lowest column tray.

The column tray according to the invention can be used as a liquid distributor, liquid redistributor, liquid collector, support tray for random packings and structured packings or as a mass transfer tray.

If the column tray is to be used as a support tray for random packings and structured packings, it preferably has small holes for the liquid throughput, the random packings and structured packings preferably being present in the intermediate spaces between the superstructures of the column, and the superstructures thus extending into the random packing or structured packing layer.

The invention also relates to a column having at least one column tray according to the invention.

The column may be an enamel-lined column, a column lined with polytetrafluoroethylene (PTFE), perfluoroalkoxy polymers (PFA), polyvinylidene fluoride (PVDF), polyethylene (PE) or similar plastic materials,

a glass column or a column made of highly corrosion-resistant metals, such as tantalum and special alloys.

Below, the invention is described in more detail with reference to the embodiments of the invention which are shown in the figures:

Fig. 1 shows a partial cross-section of a column having a column tray according to the invention, along the line I-I of Fig. 2.

Fig. 1A shows details of the inserts (distributor cups) for the relatively small holes from the region Z of Fig. 1 on a larger scale.

Fig. 2 shows a cross-sectional plan view of the column of Fig. 1 along the line II-II of Fig. 1.

Fig. 3 shows a partial cross-section of a column having a column tray according to the invention, along the line III-III of Fig. 4.

Fig. 4 shows a cross-sectional plan view of the column of Fig. 3 along the line IV-IV of Fig. 3.

Fig. 5 shows a partial cross-section of a column having a column tray according to the invention, along the line V-V of Fig. 6.

Fig. 6 shows a cross-sectional plan view of the column of Fig. 5 along the line VI-VI of

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Fig. 5.

Fig. 7 shows a partial cross-section of a column having a column tray according to the invention, along the line VII-VII of Fig. 8.

Fig. 8 shows a cross-sectional plan view of the column of Fig. 7 along the line VIII-VIII of Fig. 7.

Figures 1 and 2 show a column tray according to the invention, which can be used as a liquid distributor and liquid redistributor. Fig. 1 shows a partial cross-section of a column having a liquid distributor or liquid redistributor according to the invention, along the line I-I of Fig. 2. The column tray has a tray 100. This is as a rule mounted in the column by clamping with the aid of flanges (not shown). If the tray 100 consists of a metal coated with enamel or plastic, the coating need not necessarily extend up to the clamped borders or up to border edges. Relatively large holes for receiving the superstructures 110 and relatively small holes for receiving distributor cups 120 are formed in the tray. The superstructures 110 substantially comprise a cylinder which is closed at the top with a hood 112 and open at the bottom and in which longitudinal slots are formed above a certain level. In the embodiment shown, two longitudinal slots 111 are formed in the superstructure so that the remaining cylinder pipe 113 and the hood 112 are connected to one another only via two webs.

The superstructure 110 is mounted in the tray 100 by

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means of a screw connection or a plug connection. The superstructure 110 may also be fastened to the tray in another manner.

5 For the sake of clarity, the superstructures 110 and distributor cups 120 which do not lie on the line I-I of Fig. 1 have been omitted in Fig. 1.

10 Fig. 1A shows a distributor cup from the region Z of Fig. 1 on a larger scale. A cross-section of the distributor cup 120 is shown at the top of the circle. The distributor cup 120 has an upper border 121, a cylindrical side wall 122, a bottom 123, and outlet orifices 124 in the tray and optionally at the  
15 circumference. A view of the distributor cup 120 from below is shown in the lower part of Fig. 1A.

Fig. 2 shows a cross-sectional plan view of the column of Fig. 1 along the line II-II of Fig. 1. The  
20 distribution of the superstructures 110 and of the distributor cups 120 are better recognizable in this view. It can be seen that the distributor cups 120 are distributed virtually uniformly in order to provide as homogeneous a distribution as possible of the liquid  
25 over the cross-section.

In the embodiment according to Figures 1 and 2, liquid and gas are passed separately on the column tray. The upward-flowing gas is diverted slightly and passed  
30 upwards through the superstructure (vapour/gas chimney). Consequently, the pressure drop on the gas side in the region of the distributor is reduced to a minimum.



The superstructure 110 is designed in such a way that the vapours/gases emerge laterally above the liquid level. The superstructures 110 are covered with a hood 112 in order to prevent entry of the liquid arriving from the structured packing above. The superstructure 110 (chimney) used in the tray 100 has, in its lower region 113, a closed cylindrical shape in order to permit backup of the liquid on the tray 100. The distribution of the liquid over the column cross-section is ensured by means of the distributor cups 120. The distributor cups 120 are inserted into the relatively small holes of the tray 110 and are provided with holes 124 in the outflow part. The number of holes and the hole diameter are dimensioned by a person skilled in the art so that a liquid backup on the tray 100 is ensured in order to obtain a uniform distribution over the column cross-section. In the case of a low liquid load of, for example,  $B < 2\text{m}^3/\text{m}^2\text{h}$ , the holes in the distributor cups 120 can be equipped with additional small distributor tubes in order to obtain a better distribution over the structured packing or random packing.

It is also possible to provide overflow bushes having lateral slots or holes above the tray instead of the distributor cups.

In the following embodiments, the reference numerals of the components corresponding to the components of the first embodiment (Figures 1 and 2) were each incremented by 100.

In certain modes of operation of the column, it is

necessary to withdraw a liquid side take-off of the column. A liquid collector is used for this purpose.

Figures 3 and 4 show a column tray according to the invention which can be used as a liquid collector. Fig. 3 shows a partial cross-section of a column having a liquid collector according to the invention, along the line III-III of Fig. 4, while Fig. 4 shows a cross-sectional plan view of the column of Fig. 3 along the line IV-IV of Fig. 3.

The tray 200 of the column tray has only holes with a large diameter, in which the superstructures 210 are held. Holes having a smaller diameter are not provided.

The superstructures 210 correspond to the superstructures 110 of the embodiment of Figures 1 and 2. The height of the closed cylinder wall 213 depends on the height of the connecting piece 201 for the liquid outflow from the column. It is such that total removal of the liquid from the tray can be carried out.

The closed cylindrical height of one or more (depending on the column diameter) superstructures 210A which are equipped with an outflow pipe is slightly less than the height of the other superstructures, in order, in the case of partial withdrawal of the liquid from the column, to convey the remainder via the outflow pipe onto the next tray.

Figures 5 and 6 show a column tray according to the invention which can be used as a support tray. Fig. 5

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shows a partial cross-section of a column having a column tray according to the invention, along the line V-V of Fig. 6. Fig. 6 shows a cross-sectional plan view of the column of Fig. 5 along the line VI-VI of Fig. 5.

The support tray according to Figures 5 and 6 substantially corresponds to the embodiment according to Figures 1 and 2. The superstructures 310 substantially correspond to the superstructures 110. The liquid is discharged through the holes 320 of relatively small diameter. By using different hole diameters, it is in principle possible to pass gas and liquid predominately past one another. By providing distributor cups or overflow bushes in the small holes, the column tray can also be used as a redistributor. In the embodiment shown, the superstructures 310 are slotted over virtually the total cylindrical height in order to obtain a large free cross-section relative to the free column cross-section. A cross-section of more than 100% can be obtained, usually in the range from 80 to 130%, preferably of 110%.

The hood 312 of the superstructures 310 is slotted or perforated for increasing the free cross-section in the direction of flow. In certain embodiments, however, the hood may also be completely absent. Thus, a free cross-section of from 70 to 97%, preferably from 75 to 95%, in the direction of flow can be obtained. By the design, according to the invention, of the column tray and the separation of gas and liquid on the tray, the pressure drop on the gas side is reduced to a minimum.

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Figures 7 and 8 show a column tray according to the invention which can be used as a mass transfer tray. The column tray shown in Fig. 7 and 8 can also have the superstructure of a flooded bubble-cap tray known per se, but, in a tray according to the invention, the tray and/or the superstructures are produced from the corrosion-resistant materials mentioned. Fig. 7 shows a partial cross-section of a column having a mass transfer tray along the line VII-VII of Fig. 8. The liquid outflow 410 is at a higher level than the upper end of the bubble-cap-like superstructures 420 with slot-like gas penetration orifices 411 in their side walls. Fig. 8 shows a cross-sectional plan view of the column of Fig. 7 along the line VIII-VIII of Fig. 7.

Bubble-caps 420 which are formed, for example, from plastic, such as PTFE, PFA, PVDF or PE, and/or from glass are inserted into the holes of the tray having a relatively small diameter. The bubble-caps 420 are slotted on the sides and permit gas penetration into the liquid layer. The liquid is passed transversely over the tray 400 and fed via outflow pipes 410 to the next lowest tray. The outflow pipes 410 are formed, for example, from plastic or glass and are inserted into holes of relatively large diameter.

As a result of the design, according to the invention, of the column tray with hole diameters which can be chosen to be different and variations of the superstructures for mounting on the tray, comprising materials such as PTFE, PFA, PVDF, PE or glass, etc., the invention can be used in a very wide range of applications for operating columns, preferably of

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steel/enamel, steel/PTFE/PFA or glass or highly corrosion-resistant metals, such as tantalum and special alloys, also at a very high gas and liquid load, as may occur today with the use of high-performance random packings and structured packings.

The column trays according to the invention have the further advantage that, with a universally combinable corrosion-resistant base tray having suitable holes for receiving various superstructures and optionally smaller holes for the liquid outflow, into which holes distributor cups can be inserted, a very wide range of variants of corrosion-resistant column trays for very different intended applications can be produced merely by choosing the superstructures and inserts adapted to the respective intended use, for example, superstructures of the types shown in the present Application, and possibly by changing the middle bore and optionally also closing the small bores according to the modular principle. This considerably reduces the costs of production and maintenance.

It is furthermore within the scope of the present invention separately to provide and to market superstructures for the retrofitting of trays according to the invention or optionally of suitable conventional trays, or for the conversion of existing trays for another purpose, so that the invention also relates to the production, the provision and the marketing of individual superstructures adapted according to the invention, for example, of those made of plastic and glass, for the production of trays according to the invention by the end user.